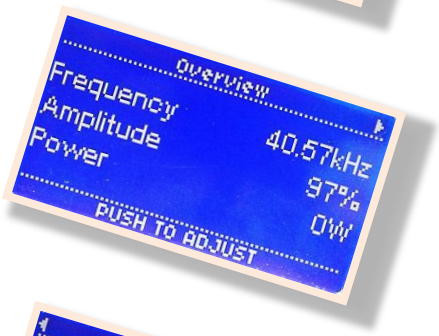
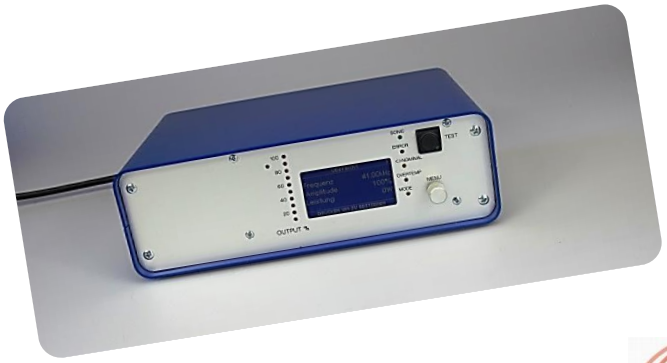
soniKKs
ULTRASONICS TECHNOLOGY

User Manual
Display and Firmware
Generator model “W“
with rotary encoder





soniKKs GmbH
ULTRASONICS TECHNOLOGY

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Parameters' security

The unit features a unique two-level security concept based on numeric passwords.

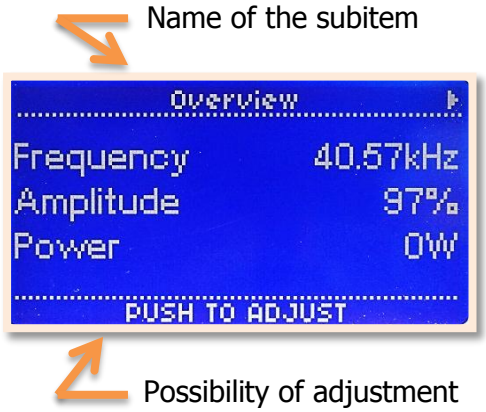
- User settings: Password-Level 1
- Reseller settings: Password-Level 3

Please ask your retailer or your manufacturer for the passwords.

Menu items and operation

The generator is operated by a **rotary encoder**, which can be turned as well as pushed. This makes the operation **very easy and comfortable**.

The menu is structured in several subitems (see navigation chart). You can change between the items by turning the rotary encoder.



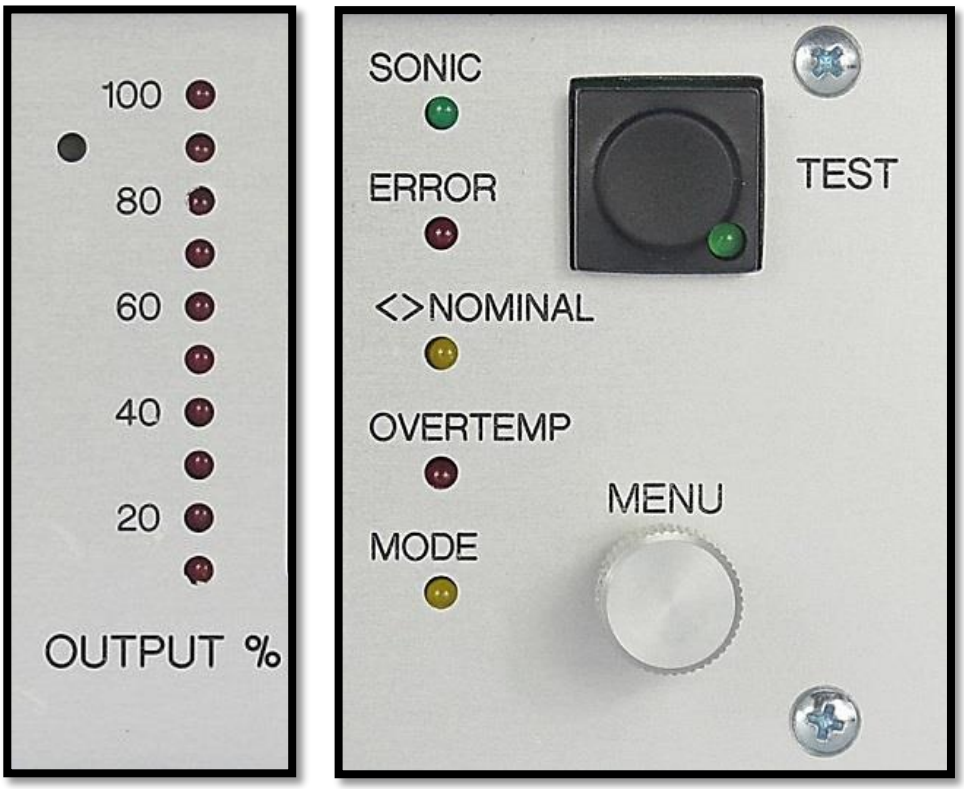
The top bar of the screen indicates the **name of the subitem**, while the bottom bar tells you if **adjustments can be done** in this screen (see also color code of navigation chart). If so, the bottom bar will display "PUSH TO ADJUST" (see screenshot on the right) or "PUSH TO RESET".

To enter the adjustment mode, push the rotary encoder as suggested. A value will then be highlighted, meaning that you can modify it by turning the encoder. Once you have selected the value/option of your choice, push the encoder again to validate the change.

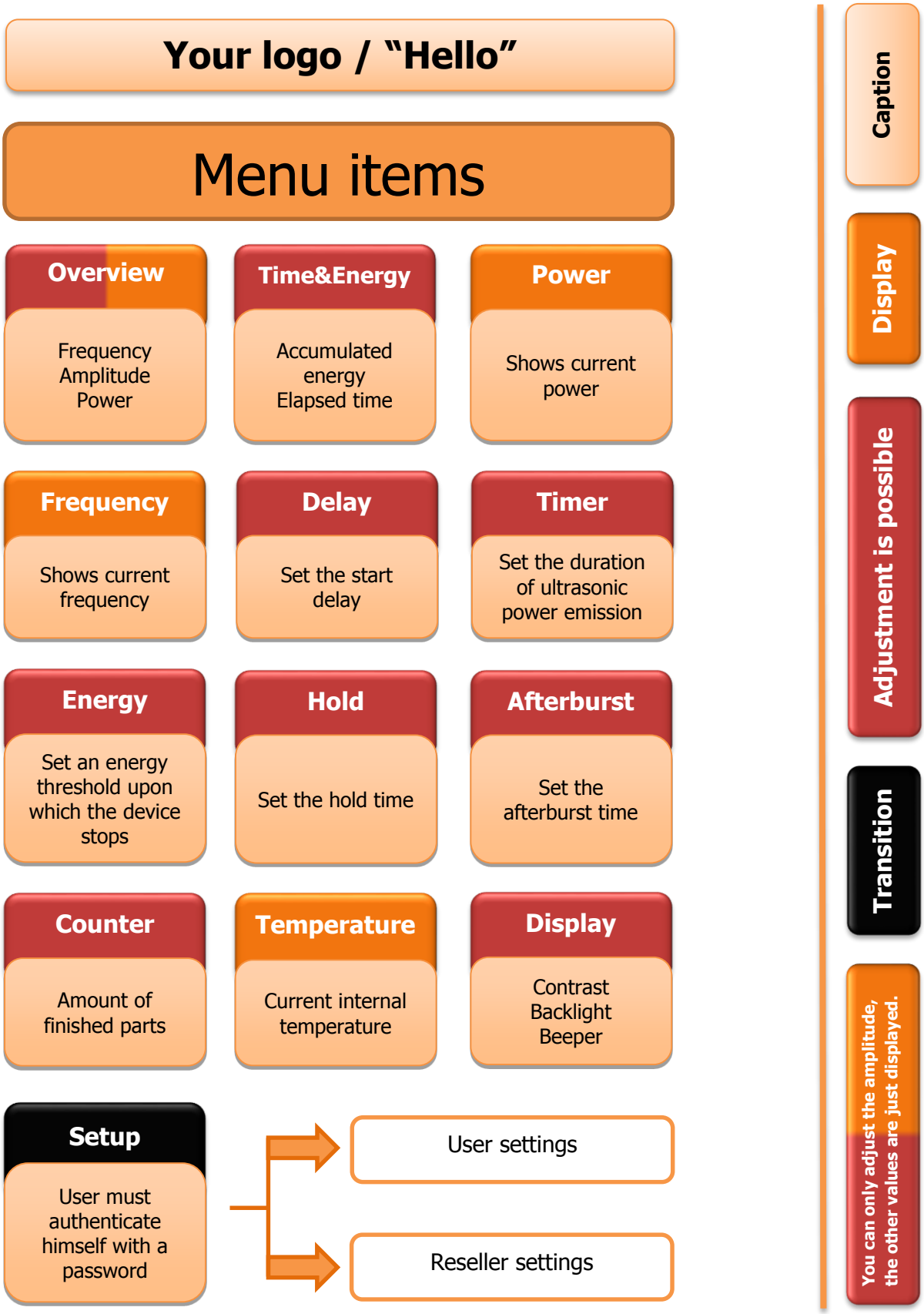
As you can see in the screenshot above, some screens can contain several editable values. In this case, the values are edited in turn from the top to the bottom. Validating the changes of the last editable value will then close the adjustment mode.

Status LEDs

"Sonic" LED	ON: ultrasonic power is active.
"Error" LED	ON: there is a malfunction of the generator.
"< > Nominal" LED	No function in this version.
"Overtemp." LED	➔ ON: the generator is overheating and the over temperature fuse has shut off the generator. ➔ Blinking: the generator was shut down during the last welding process due to over temperature. The LED turns off if you start the generator again.
"Mode" LED	➔ ON: the generator is set to stop after a predetermined condition is reached. These conditions are time or energy. ➔ Blinking: one (or more) welding cycle parameter is set
"Output %" gauge	Indicates the effective ultrasonic power in steps of 10% of the nominal power.



Navigation chart



Settings

User Settings

Start frequ.
Adjust start frequency

Nominal Source
External voltage
Front / Comm. bus

Testbutton
Off
Push
Latch
Trigger

Remote start mode
Latch
Static
Trigger

Transducer Temperature
Current temperature of transducer

Info
Shows information about the device

Exit
Back to menu items

Display

Adjustment is possible

Transition

Settings (continued)

Reseller settings

Screens	Language	Greetings
(de-)activate more functions	English German French Spanish Polish	Hello/Logo (Startup message)
Runtime	**Error relay polarity**	**Sonic relay polarity**
Monitor operating time (also resettable)	Normally open Normally closed	Normally open Normally closed
Sonic relay mode	**Offsets**	**Transducer limit**
HF status Cycle	A min offset A max offset	Set limit for temperature of the connected transducer
Factory settings	**Network Settings**	**Parameter Locking**
Restore factory settings	Config. Mode IP address Netmask MB Pipeline MB Exceptions	Lock parameter adjustment in certain screens
Exit		
Back to menu items		

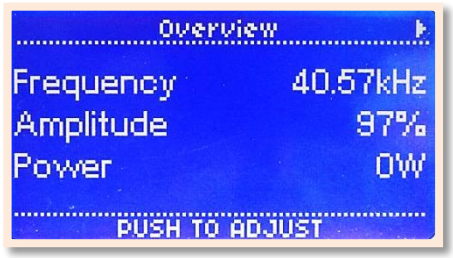
Display

Adjustment is possible

Transition

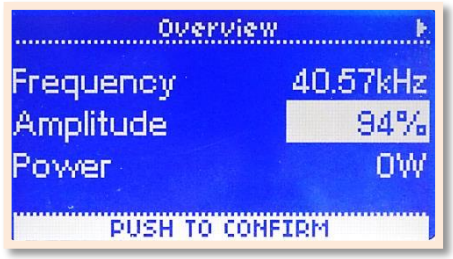
Structure of the menu and functions

1. Overview



The overview displays the current working frequency of the device. If there is no ultrasonic output, the start frequency is displayed.

Here you can adjust the desired amplitude. Push the rotary encoder to activate the adjustment mode. The line where the amplitude-value is displayed is now marked. Turning the rotary encoder right, decreases the value – turning left increases the value. To close the adjustment mode, push the rotary encoder again.



"Amplitude"	
Valid interval	50 – 100 %
Resolution	1% steps

2. Time & Energy

In this screen the accumulated energy is displayed as well as the duration of the last process ("elapsed time").

3. Power

Here you can read out the currently emitted power.

4. Frequency

In this screen the current working frequency of the device is shown. If there is no ultrasonic output, the start frequency is displayed.

5. Delay

This screen makes it possible to use a start delay, which is the time between the user's start request (via the remote) and the actual start of the device.

See the Welding Cycle mode section for further information.

6. Timer

The generator features two special operation modes:

- Welding on time ("Timer")
- Welding on energy ("Energy")

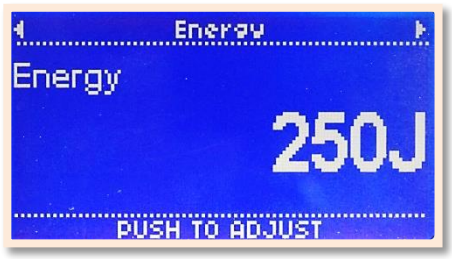
Both operation modes can be used simultaneously and are indicated by the Mode-LED.

If the Timer-function is activated, the generator automatically turns off when the predetermined time value is reached. Thus, it is possible to make welding processes on a specified time.

Push the rotary encoder to start the adjustment mode. Turn it until the desired value is reached. To close the adjustment mode please push the rotary encoder again.

"Timer"	
Valid interval	0(=off) - 99.999 s
Resolution	1 ms

7. Energy



The generator features two special operation modes:

- Welding on time ("Timer")
- Welding on energy ("Energy")

Both operation modes can be used simultaneously and are indicated by the Mode-LED.

If the energy function is activated, the generator turns off automatically when the predetermined energy value is reached. This makes sure that you have the same input energy in every welding process.

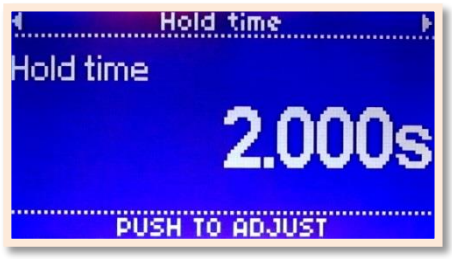
In case you use both operation modes simultaneously, the value which is reached first turns the generator off.

E.g. if energy and timer are activated, the timer works as a time limit. If this time limit is reached, before the predetermined energy value is reached, the generator turns off automatically.

In this screen you can determine the desired energy value. Please push the rotary encoder to activate the adjustment mode. Turn it until your desired value is reached. To close the adjustment mode please push the rotary encoder again.

"Energy"	
Valid interval	0(=off) - 9999 J
Resolution	1 Joule

8. Hold time



The hold time is available if your device is configured in welding cycle mode. Once your welding press has squeezed the parts to solder together and applied the ultrasounds to them, the press will keep squeezing them together for the specified "hold" time.

It enables to maintain the parts still during the cooling down of the solder.

See the Welding Cycle mode section for further information.

9. Afterburst

In welding cycle mode, the afterburst is the final step of the cycle. After the hold time, while the press releases the parts, some material may stick to the sonotrode.

Setting an afterburst time will make the generator clean the sonotrode by emitting an additional burst of ultrasounds.

See the Welding Cycle mode section for further information.

10. Counter

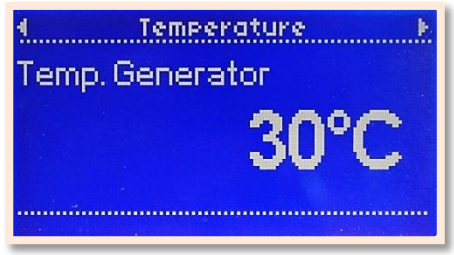
The Counter works as a part counter and shows the amount of finished parts.

You can reset the counter by pushing the rotary encoder as suggested in the bottom bar.

A pop-up window will invite you to confirm your request. The option is selected when highlighted. Select "yes" to confirm or "no" to cancel.

11. Temperature

This screen displays the internal temperature of the generator.



If your generator is not equipped with a temperature sensor, the bottom bar will display the "NOT AVAILABLE" message.

12. Display

Here you can tune display-related parameters such as the contrast and the backlight. You can also activate/de-activate the beeper.

Push the rotary encoder to enter adjustment mode.

Select the desired contrast level by turning the encoder and push it to confirm the change.

Repeat the same operation for the backlight. As you will notice, you can choose between the three options below:

- ✓ On: the backlight is switched on permanently
- ✓ Auto: the backlight switches automatically off after a while if the generator is not used
- ✓ Dim: the backlight is dimmed to a low level

Push again to set the displayed option and go on to the beeper adjustment. Choose between "On" and "Off". When ready, push one last time to apply the change and quit the adjustment mode.

13. Setup

To change the settings you need a numeric password.

In the navigation chart, you can see which settings require which password-level.

- ➢ User settings: Password-Level 1
- ➢ Reseller settings: Password-Level 3

Upon entering adjustment mode, the screen on the right appears. The digits are set one by one by turning and pushing the encoder. In order to reach the desired settings, you will have to enter the corresponding password.

Please ask your reseller or manufacturer for the passwords.

13.1. User settings

➢ START FREQUENCY

ATTENTION:

The adjustment of the start frequency should only be done by experienced personnel. The start frequency always has to be adjusted higher than the resonance frequency of the connected transducer system. If the resonance frequency of the connected transducer system is unknown, use the standard frequencies shown in the chart.

Generator model	Start frequency
20 kHz	20,5 kHz
30 kHz	30,5 kHz
35 kHz	35,5 kHz
40 kHz	40,5 kHz
60 kHz	60,5 kHz

If the generator is started, the displayed frequen[illegible] resonance frequency of the system.

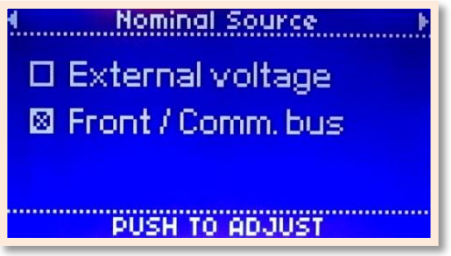
Setting the start frequency too close to the resonance frequency of the system might cause the error "amplitude protection active". In this case please set the start frequency to a higher value. (See also: Troubleshooting)

In this menu the start frequency can be adjusted by pushing and turning the rotary encoder.

"Start Frequency"	
Valid interval	Manufacturer setting
Resolution	10 Hz

➢ NOMINAL SOURCE

The amplitude can be controlled by an external voltage or tuned via the user interface: the encoder and the communication buses.



Push the rotary encoder to activate the adjustment mode. The currently set option is now highlighted. By turning the encoder, you can switch between the two options. When the desired option is highlighted, push the encoder again. Herewith, you confirm the setting and exit the adjustment mode.

✓ External voltage: the amplitude can no longer be adjusted with the rotary encoder.

Instead, it is set by an external voltage 5-10V (standard) or rather 0-10V (user specific adjustment), that corresponds to 50-100% output power.

✓ Front/Comm. Bus: the nominal power can directly be adjusted via the rotary encoder or the different communication buses.

➢ TESTBUTTON

In this screen you can adjust how the test-button („Test") works. 4 options are available: "off", "Push", "Latch" and "Trigger".

Proceed as usual to activate the adjustment mode and change the settings.

✓ Off: the test-button has no function

✓ Push: as long as you push the test-button the generator is on

✓ Latch: pushing the testbutton switches the generator on,
pushing again switches the generator off

✓ Trigger: this option is only recommended when at least one of the special operation modes (Timer or Energy) is used. A short (Trigger) pulse starts the generator. The device automatically switches off when the predetermined time or energy is reached.
→see draft in item-description "Remote start mode"

➢ REMOTE START MODE

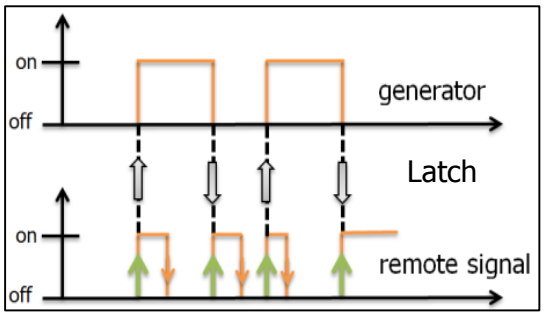
Here you can adjust how the remote signal works. You can choose between the options "Latch", "Static" and "Trigger".

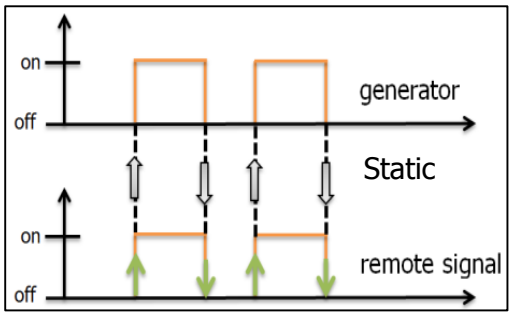
Proceed as usual to activate the adjustment mode and change the settings.

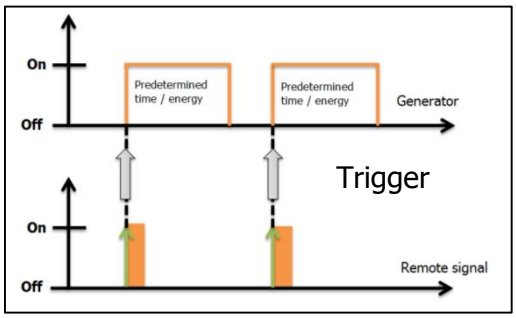
✓ Latch: a pulse switches the generator on,
a second pulse switches the generator back off.
→Storage function

✓ Static: the generator is on as long as the remote signal is active.
→No storage function

✓ Trigger: this option is only recommended when at least one of the special operation modes (Timer or Energy) is used. A short pulse starts the generator. The device automatically switches off when the predetermined time or energy is reached.







➢ TRANSDUCER TEMPERATURE

In this screen you can read out the current temperature of the transducer.

This feature is only active if a transducer with temperature sensor function is connected.

➢ **INFO**

Here you can see some information about the device:

- ✓ Engine: Firmware revision of the core
- ✓ Display: Firmware revision of the front board
- ✓ Datecode: date of production
- ✓ Serial#: Serial-number of the device
- ✓ Runtime: (total) operating time (h:mm:ss)

➢ **EXIT**

Pushing the rotary encoder leaves the setup menu and leads back to the "Overview" screen.

13.2. Reseller settings

➢ **SCREENS**

In this screen you can selectively disable or enable menu items. If there is a cross in the check-box, this menu item is shown in the menu. If there is no cross, the menu item is not shown in the menu.

In the factory presets only the functions "Timer" and "Energy" are activated. For more information about the functions please ask your reseller or manufacturer.

We recommend deactivating all the functions that you do not need. Like this your item menu is more adapted to your requirements.

Proceed as usual to activate the adjustment mode and change the setting.

LANGUAGE

Here you can select the language in which the screens' contents are displayed.

Our generators are currently configurable to five different languages: English, German, French, Spanish and Polish.

Proceed as usual to activate the adjustment mode and change the settings.

ATTENTION: For your own safety, do not choose a language you do not speak. The language changes immediately by confirming your choice and the menu appears in the chosen language, which could be foreign to you.

GREETINGS

This screen allows you to select what will be displayed on startup. You can either choose to display the stored logo (personal logo on request) or a simple "Hello" message.

RUNTIME

Here you can read out the (total) operating time of the generator. Format: h:mm:ss.

Reset of the runtime is possible. Proceed as usual to activate the adjustment mode and change the settings.

ERROR RELAY POLARITY

In this screen, you can adjust the behavior of the internal error relay. The current configuration is indicated by a ticked check box.

The relay can either behave as a normally open or a normally closed contactor.

"Normally open" means that the relay will be closed upon failure of the generator. Conversely, the relay will be opened upon failure if the relay polarity is set to "normally closed".

➢ SONIC RELAY POLARITY

In this screen, you can adjust the behavior of the internal sonic relay. The current configuration is indicated by a ticked check box.

The relay can either behave as a normally open or a normally closed contactor.

"Normally open" means that the relay will be closed upon start of the generator. Conversely, the relay will be opened upon stop if the relay polarity is set to "normally closed".

➢ HF RELAY MODE

This screen is only available if the cycle timer option has been activated on your generator. It can be done on request by the manufacturer.

In this screen, you can set the behavior of the "**HF – DA**" internal relay to one of the two options below:

- ✓ HF Status: the relay behaves like in the Standard mode (Welding Cycle mode disabled). It indicates an active-level (high or low depending on its polarity) if the generator is emitting ultrasonic power.
- ✓ Cycle: the relay indicates an active-level (high or low depending on its polarity) as long as the welding cycle is not complete.

➢ OFFSETS

ATTENTION:

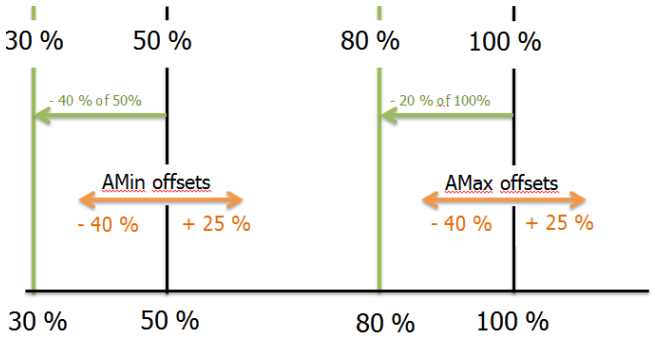
It is only permitted to adjust the amplitude after having consulted the manufacturer. Danger of damaging the transducer system!

In this screen you can adjust the amplitude offsets "A min offset" and "A max offset".

Proceed as usual to activate the adjustment mode and change the settings.

"A min / max offset"	
Valid interval	-40 % and +50 %
Resolution	1 % steps

✓ The value, which you define for "A min offset" changes the usually minimal amplitude adjustment 50 %.
Example: If you choose – 40 % for "A min offset.", the absolute value 50 % is downsized through 40 % of his own value (40% of 50) → 50 – 20 = 30
The amplitude value would be 30 %.

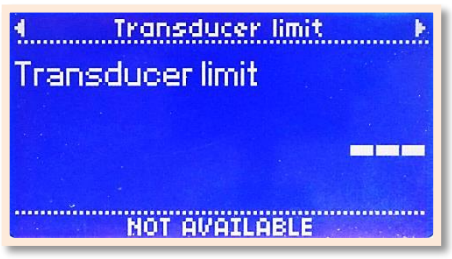


✓ The value, which you define for "A max offset" changes the usually maximal amplitude adjustment 100 %
Example: If you choose – 20 & for "A max offset", the absolute value 100 % is downsized through 20 % of his own value (20% of 100) → 100 – 20 = 80
The amplitude value would be 80 %.

➢ TRANSDUCER LIMIT

In this screen you can determine a temperature value. If the temperature of the transducer reaches this value, the generator switches off automatically (for reasons of safety of the transducer).

This option is only available if a transducer with temperature sensor function is connected.



FACTORY SETTINGS

A confirmation dialog will appear if you push the encoder. By choosing yes, the factory settings will be restored.

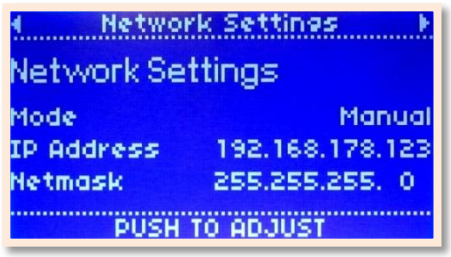
NETWORK SETTINGS

This screen deals with the generator's network parameters. It only concerns welding generators which feature an embedded server.

If your generator does not have any, the message on the right will be displayed.

Otherwise, the current configuration of your device will be displayed and adjustable.

Please refer to the Modbus section (page 27) for further information about this feature.



Depending on the configuration, three or less parameters are displayed :

- ✓ Mode: the IP configuration mode (Manual, AutoIP, DHCP, BOOTP…).
  Choosing a manual configuration mode will lead you to set an IP address and a netmask yourself.
  Any other mode is an automatic mode, for which the IP address and the netmask are provided automatically to the generator.

In manual mode, the two parameters below are adjustable:

- ✓ IP address: the IP address used by the device on the network. It can only be set when the mode is set to Manual. In automatic mode, this line will not be displayed.
- ✓ Netmask: the netmask used by the device on the network. It can only be adjusted in manual mode. In automatic mode, this line will not be displayed.

Once you have set the parameters above, two additional Modbus/TCP-related settings appear:

- ✓ Modbus Pipeline: the pipeline behavior of your Modbus/TCP connection can be adjusted by turning the encoder. When set, the generator will queue the polls it receives and answer all of them in turn. When disabled, the generator only answers the last received poll and discards all stale polls. This feature is enabled by defaut.

- ✓ Modbus Exceptions: traditional Modbus uses silence to signal some errors (e.g. unconfigured slave address, timeout, CRC error…). Setting this parameter will cause the generator to issue error messages instead, specifying the cause of the error.

➢ PARAMETER LOCKING

The parameter locking enables the supervisor to restrict access to the following parameters: Amplitude, Delay, Timer, Energy, Hold, Afterburst, Counter and Start Frequency.

In order to lock them, you have to lock the corresponding screen (e.g. "Overview" for the amplitude).

When a screen is locked, the bottom bar then shows "LOCKED" instead of "PUSH TO ADJUST". Trying to adjust parameters while the "parameter locking" is active will lead to an audio warning and of course the access will be refused.

➢ EXIT

Pushing the rotary encoder leaves the setup menu and leads back to the "Overview" screen.

Welding Cycle mode

If your generator is configured for cycle welding, please take into consideration the following section in addition to the previous chapters.

1. Purpose of the feature

The cycle mode has been designed to be used together with ultrasonic welding presses that do not feature a built-in controller.

Controllers are commonly used in welding chains, to make them more efficient and to improve their cadence. In order to do this, the controller makes sure that the ultrasonic energy is automatically delivered to the sonotrode at specific periods of the welding cycle: during the welding time (when the pieces are pressed against each other) and optionally during an afterburst. Therefore, the welding cycles can be completed faster, without any waste of time.

Thanks to this helpful feature, the soniKKs Welding Generator can replace such a controller, giving your ultrasonic presses the "intelligence" they are lacking.

2. Status LEDs

The behaviors and meaning of the status LEDs of the generator are globally the same as described on page 4. The only changes concern the "Error" LED and the "Mode" LED, which will work as follows.

Error – LED	• Welding Cycle mode **disabled**: ➔ ON: an error occurred • Welding Cycle mode **enabled**: ➔ ON: an error occured ➔ Blinking: the weld time has expired whereas the energy threshold has not been reached (see the Timing chart)
Mode – LED	• Welding Cycle mode **disabled**: ➔ ON: the generator is set to a timer or energy mode. • Welding Cycle mode **enabled**: ➔ ON: a welding cycle is ongoing.

3. Testbutton function

Please note that the testbutton's function remains the same whether the Welding Cycle feature is enabled or not.

The generator will emit ultrasonic power as long as the testbutton signal is active (see the Testbutton and Remote sections, page 15). It cannot be used to start a cycle for instance.

Of course, the testbutton will be ignored during the welding cycles.

4. Parameters of the welding cycle

The welding cycle can include up to four steps, whose durations can be tuned by the user.

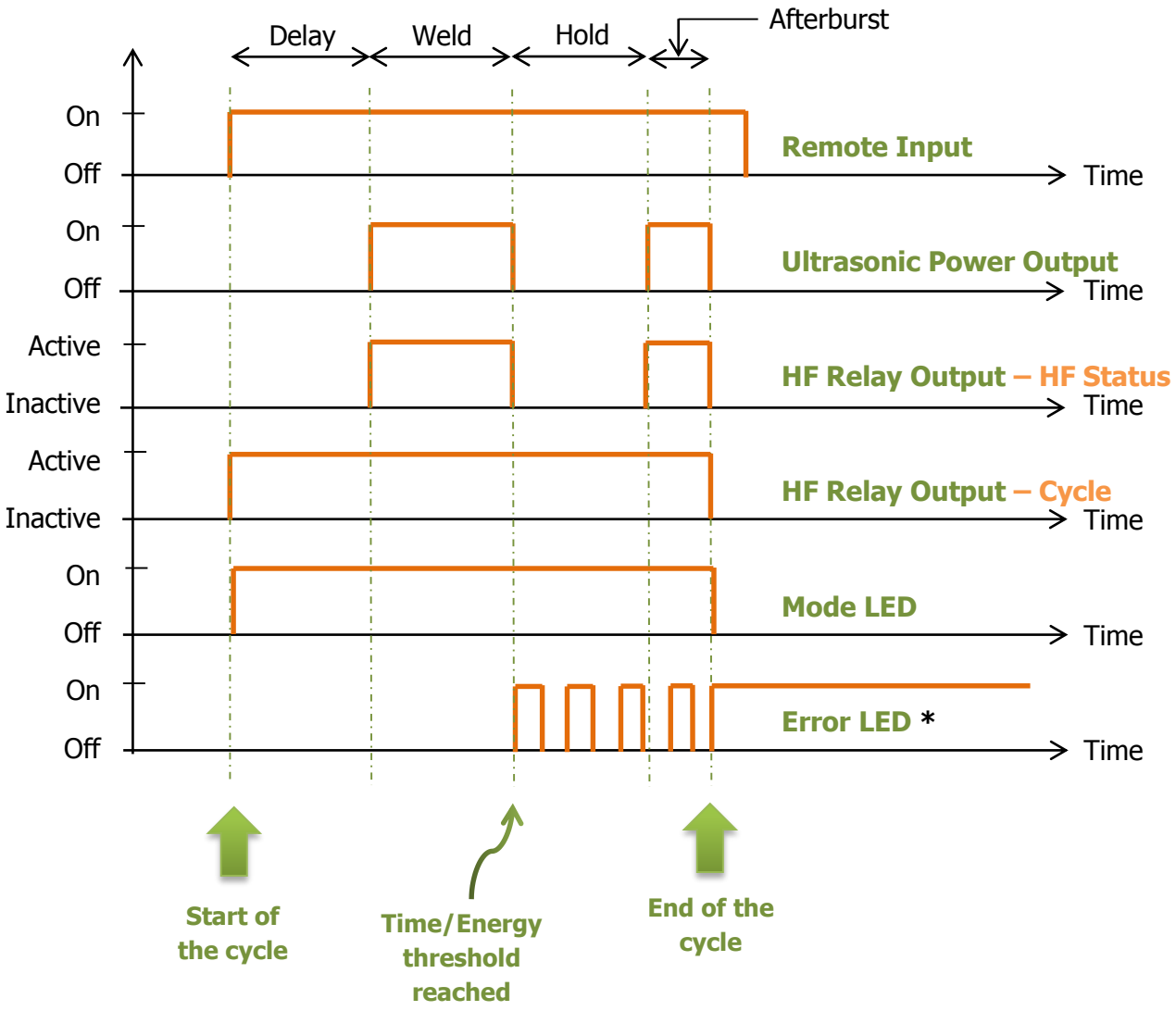
The different times of the welding cycle are:

- ✓ **Delay:** the delay between the moment the remote input is activated and the weld time starts.
- ✓ **Weld Time/Energy:** the generator emits ultrasonic power until the specified time/energy threshold is reached. If both thresholds are set, the generator stops as soon as one of the two is reached.
- ✓ **Hold Time:** a delay time after the generator has stopped emitting ultrasonic power. This phase enables the press to hold the pieces while the weld cools down.
- ✓ **Afterburst:** the time during which the generator will emit ultrasonic power at the end of the cycle. The afterburst is used to remove the residues of material from the sonotrode.

In addition, the user can also configure the Sonic output relay to act as a cycle status (as explained on page 20). The output will then be active during the whole cycle, i.e. from the start of the delay phase to the end of the afterburst phase.

5. Timing chart

The graph below illustrates the welding cycle and its timings.



* This behavior only applies in the case when a Weld Time and a Weld Energy are both set, and the Weld Time expires before the Weld Energy is reached.

Operation over Modbus/TCP

The soniKKs welding generators can be equipped with an embedded server that enables them to be operated over TCP/IP using the Modbus/TCP protocol. For these devices, the user can configure the network settings as explained in this chapter.

1. Basic network information

1.1. IP Configuration Mode

The IP address of the device can be set manually (in which case it is called a "static" address) or automatically by an auto-configuration server, commonly a DHCP server (it is then called a "dynamic" address).

In manual addressing mode, the user sets the IP address himself, and can additionally set a netmask (see explanations below). This "static" configuration will remain the same as long as the user does not change it again.

The automatic addressing mode includes different modes that correspond to different auto-configuration protocols:

- ✓ **AutoIP:** the server automatically generates its own IP in the 169.254.x.x range with a Class B subnet.
- ✓ **Dynamic Host Configuration Protocol (DHCP):** a DHCP configuration server will automatically provide the server with an IP address taken from its own pool of available addresses.
- ✓ **Bootstrap Protocol (BOOTP):** a BOOTP configuration server will automatically provide the server with an IP address taken from its own pool of available addresses.

NB: The user can enable either one of those modes or several modes at the same time.

1.2. IP address

The IP address is an identifier that allows a device to connect to an IP network. Each device present on the network has a unique IP address in order to be reached easily.

The Modbus/TCP servers integrated in soniKKs generators use an IPv4 address that consists of a 32-bit word that is usually given in the "dotted decimal" notation: four decimal numbers ranging from 0 to 255 separated by dots (ex: 192.168.178.123).

The IP address contains two pieces of information that are the **network number** and the **host number**, which is the actual identifier of the device on the network.

The size of these numbers, which means the number of bits dedicated respectively to the network and the host ID, is defined by the first three bits of the address as follows.

Network Class	Leading bits	Size of network number bit field	Size of host number bit field
A	000	8	24
B	010	16	16
C	110	24	8

1.3. Netmask

In IPv4, the netmask, also called "subnet mask", is a 32-bit word used to divide a network into subnetworks. As for the IP address, it is commonly given in the dotted decimal notation.

This mask is used to indicate which part of the IP address corresponds to the network address, and thus which part corresponds to the host identifier. The "ones" delimit the bit field of the network whereas the "zeros" indicate the host's bit field.

2. Modbus/TCP protocol overview

NB: For more detailed information about the Modbus protocol, you may want to refer to the official documentation available at http://www.modbus.org/

Modbus is a "Master-Slave" protocol used for supervisory control and data acquisition (SCADA), in which the master (usually a PLC) can obtain and modify parameters contained in the slave's memory via "Read/ Write" commands. Only the master can send commands to the slave which executes it and systematically sends back a response (even for Write commands).

2.1. Modbus/TCP pattern

A typical Modbus/TCP frame is formatted as shown below. It is composed of a 7-byte header that contains indications about the message, followed by the actual data to be transmitted.

	Transaction ID	Protocole	Length	Slave ID	Function	Data
Example:	00 58_h	00 00_h	00 06_h	01_h	04_h	0B BE 00 06_h

The different packets have the following significations:

	Length	Description
Transact. ID	2 bytes	On a network, a master can send many requests in a short time and the answers to these requests may come in another order. This identifier allows the master to link each response it receives to one command it has sent. Thus, each request has a unique identifier that the response also contains.
Protocole	2 bytes	These 2 bytes indicate which protocol is used. 00 00_h corresponds to Modbus/TCP.
Length	2 bytes	The number of bytes contained in the rest of the message (slave ID, Function and Data).
Slave ID	1 byte	The device address on the network. Each slave present on the network has its own ID number (from 1 to 247), allowing the master to indicate the recipient of the command (i.e. to which device it is addressed). Note that messages sent to slave 0 are processed by all the slaves.
Function	1 byte	The code for the function that the slave must perform. The Modbus specification defines a set of functions (see below) and assigns a code to each of them.
Data	N bytes	Additional data accompanying the function code such as the address of the starting register, the number of registers concerned and the data to be written (for Write commands).

NB: the values are in hexadecimal (marked "h"), that is to say that 2 digits represent 1 byte.

2.2. Data types in Modbus

Modbus differentiates 4 data-types based on length and accessibility criteria.

- Coils: The coils are one-bit values that can be modified as well as read (e.g. on/off command, enable/disable a mode…).
- Discrete Inputs: The discrete inputs are one-bit values that cannot be modified by the master. They usually are status and thus can only be read (e.g. run status, error status…).
- Input Registers: The input registers are read-only values that can occupy one or more registers depending on their length. They are usually used for sensor measurements (current temperature, current power…).
- Holding Registers: The holding registers are read/write values that can also occupy

several registers. They are usally used for configurable parameters such as nominal values, thresholds…

2.3. Modbus memory map and functions

The parameters are stored in the slave's memory in 16-bit registers. The Modbus protocol defines a memory map that separates the 4 data-types depicted above. Therefore, the memory is subdivided in 4 blocks of registers which contain our parameters. In the array below, you can see that each of these blocks can be accessed using its appropriate functions. For instance, the coils (registers 1 to 9999) can be read thanks to function 01 only.

Function	Code		Register Addresses
Read Coils	01_d	01_h	1 - 9999
Write Single Coil	05_d	05_h	
Write Multiple Coils	15_d	$0F_h$	
Read Discrete Inputs	02_d	02_h	10001 - 19999
Read Input Registers	04_d	04_h	30001 - 39999
Read Holding Registers	03_d	03_h	40001 - 49999
Write Single Holding Register	06_d	06_h	
Write Multiple Holding Registers	16_d	10_h	

In the messages, however, the master always specifies an address between 0 and 9998_d ($270E_h$). When processing the message, the slave will then add an offset corresponding to the block implied by the function code: 1 for the coils, 10001 for the discrete inputs, 30001 for the input registers and 40001 for the holding registers.

2.4. Modbus exceptions

The Modbus protocol also features some error recognition cases, called exceptions. When a command is sent, there are 4 possible outcomes:

- It does not reach the slave → the master gets no response.
- It reaches the slave with some glitches → parity or CRC error → the master gets no response.
- It reaches the slave with no transmission error and is successfully processed by the slave → the master gets a valid response.
- It reaches the slave with no transmission error but the command cannot be processed → the master gets an exception response indicating the cause of the failure.

The exception response has the following pattern:

	Transaction ID	Protocole	Length	Slave ID	Function	Data
Master:	00 58_h	00 00_h	00 06_h	01_h	03_h	00 00 00 $0A_h$
Slave:	00 58_h	00 00_h	00 03_h	01_h	83_h	02_h

In this example the master asks slave number 1 to read the content of the holding registers area (03_h) starting at address 40001_d (00 00_h) and including 10_d registers (00 $0A_h$).

The exception is recognizable thanks to the function field. It is signaled by the slave by setting the first bit of the function code to 1. The nature of the exception is then indicated by the data field: 02_h corresponds to an Illegal Data Address for instance.

Please refer to the Modbus official documentation for the description of all possible exceptions.

3. Operating a soniKKs Welding Generator over Modbus/TCP

3.1. Configuring the generator's network settings

To access your device over the network, here is how to proceed:

- Ask your administrator for this information:
  - ✓ An available IP address
  - ✓ The netmask
- Start your generator.
- Go to the Network Settings screen in the level-3 settings.
- Set the configuration mode to "Manual" and enter your IP address and netmask.
- Now configure the Modbus/TCP parameters (pipeline, exceptions). First, try with the default settings.
- Confirm the changes.
- Power-cycle your generator in order for the changes to be applied.

- Connect your Modbus/TCP master and wait until the left LED of the Ethernet port is steady green.

3.2. Specifications and adjustments

Modbus/TCP connections to the generator should be established using TCP port #502.

A **500ms connection timeout** makes the connection restart if no poll has been performed in this time frame. Thus, please make sure that the **poll rate respects this timeout**, otherwise the connection will restart indefinitely (see Technical Support on page 35).

The efficiency of the Modbus/TCP protocol is well-known. However, it requires an accurate adjustment of the master and slave settings. Therefore, you will have to give great attention to your master's tuning in order to optimize the link between your master and the generator. If your knowledge about Modbus/TCP is limited, you can refer to the paragraph called "Recommended poll rates" of the Technical Support.

Regarding the slave (the generator), two parameters are adjustable:

- The **pipeline** option: in pipeline mode, the slave processes every command present in its TCP stack, one after the other. When the option is deactivated, the slave only responds to the newest command and ignores all other commands of the stack. This way, it allows the master to retry old requests without risking building up a stale queue of waiting requests.
  The pipeline option is enabled by default. You should disable it only if you are having problems.

- The **exceptions** option: Traditional serial Modbus uses silence to signal some errors. However, Modbus/TCP defines error codes to make the errors explicit. The soniKKs generator can return two exceptions, depending on the gravity of the error: 0x0A and 0x0B. 0x0A indicates a "hard" error where a retry is not likely to succeed. Conversely, 0x0B stands for a "soft" error where a retry may succeed.

3.3. soniKKs welding generator's Modbus map

The parameters below are accessible at the specified addresses (see also section "Modbus memory map and functions"). To simplify the notations, only the lower part of the address is shown in the tables (e.g. 44018 → 4018). **Given the nature of the Modbus addressing scheme, the address sent in the message should be:**

(register address – 1)

3.3.1. Coils (Read/Write)

Register address	Number of registers	Type	Name	Description
1001	1	Bit	Start/Stop command	0: Start the generator 1: Stop the generator
1002	1	Bit	*reserved*	*reserved*
1011	1	Bit	*reserved*	*reserved*

3.3.2. Discrete Inputs (Read only)

Register address	Number of registers	Type	Name	Description
2001	1	Bit	HF Status	0: No HF detected on output 1: HF detected on output
2002	1	Bit	ON/OFF Status	0: The generator is not emitting power 1: The generator is emitting power
2003	1	Bit	Error Status	0: Status OK 1: Status Error
2004	1	Bit	Start Command Status	0: No start command pending 1: Start command pending
2005	1	Bit	Overtemp Status	0: Temperature OK 1: Temperature exceeded
2006	1	Bit	Run Status	0: Generator is idle 1: Generator is running(1)
2007	1	Bit	reserved	reserved

(1) Please note that the Run Status bit can be "1" even if the generator is not currently emitting power. Example: if a HoldTime and an Afterburst are set, the ON/OFF status will be "1" during the "weld time" and the afterburst, and "0" during the "hold time". As for the Run Status, it will be "1" during the whole run.

3.3.3. Input Registers (Read only)

Register address	Number of registers	Type	Name	Description
3001	1	Short	Status code	Current error code
3002	1	Short	*reserved*	*reserved*
3003	1	Short	Actual Power	Actual power level (‰)
3004	1	Short	Peak Power	Peak power from the previous run (‰)
3005	1	Short	Generator Temperature	Internal temperature (°C)
3006	1	Short	Transducer Temperature	Transducer temperature (°C)
3007	2	Long	Actual Frequency	Working frequency (Hz)
3009	2	Long	Accumulated Energy	Accumulated energy (J)
3011	2	Long	Actual Timer	Elapsed time during the current run (ms)
3013	1	Short	*reserved*	*reserved*
3014	2	Long	*reserved*	*reserved*
3101	1	Short	Nominal Min	Minimal amplitude (%)
3102	1	Short	Total Power	Maximum total output power (W)
3110	2	Long	*reserved*	*reserved*
3112	2	Long	*reserved*	*reserved*

3.3.4. Holding registers (Read/Write)

Register address	Number of registers	Type	Name	Description
4001	1	Short	Nominal Amplitude [2]	Nominal amplitude (%)
4002	1	Short	Weld Energy	Welding energy threshold (J)
4004	1	Short	*reserved*	*reserved*
4005	1	Short	*reserved*	*reserved*
4006	2	Long	Start Frequency [3]	Start frequency (Hz)
4008	2	Long	*reserved*	*reserved*
4010	2	Long	*reserved*	*reserved*
4012	2	Long	ON Time / Weld Time [4]	ON time / Welding time (ms)
4014	2	Long	*reserved*	*reserved*
4016	2	Long	*reserved*	*reserved*
4018	2	Long	*reserved*	*reserved*
4020	2	Long	*reserved*	*reserved*
4022	1	Short	*reserved*	*reserved*
4023	1	Short	Delay Time [5]	Delay time before welding (ms)
4024	2	Long	Hold Time [5]	Delay time after welding (ms)
4026	1	Short	Afterburst Time [5]	Additional US burst time (ms)

[2] Make sure that the nominal source is set to « Front / Comm. Bus » (see Nominal Source screen in the user settings).

[3] Please do not change this parameter unless you understand the implications.

[4] Used for the welding time if the Welding Cycle feature of your generator has been activated.

[5] Only available if the Welding Cycle feature of your generator has been activated. See the Welding Cycle addendum for further information.

3.4. Practical examples

Here are some actual examples that will help you start operating the soniKKs Welding Generator over Modbus/TCP.

3.4.1. Switching the generator ON and OFF

This can be done by setting/resetting the value contained in register 1001, using the "Write single coil" function (05_h). The actual address to be sent is then 1000_d (1001 – 1) which gives 03 $E8_h$.

To set and reset a coil, the values to send are respectively FF 00_h and 00 00_h.

Therefore, the message should look as follows:

	Transaction ID	Protocole	Length	Slave ID	Function	Data
Master:	00 AA_h	00 00_h	00 06_h	02_h	05_h	03 E8 FF 00_h
Slave:	00 AA_h	00 00_h	00 06_h	02_h	05_h	03 E8 FF 00_h

The slave returns the same frame (as for every write commands).

3.4.2. Adjusting the Amplitude level

The amplitude level is located in register 4001_d, and can be accessed using the "Read Holding Register" and "Write Holding Register" functions (respectively 03_h and 06_h).

To read it, the master should send the following packet:

	Transaction ID	Protocole	Length	Slave ID	Function	Data
Master:	00 AB_h	00 00_h	00 06_h	05_h	03_h	0F A0 00 01_h
Slave:	00 AB_h	00 00_h	00 05_h	05_h	03_h	02 00 53_h

The master requests the slave number 5 to read in the holding register area (function 03_h) starting at address 0F $A0_h$ (4000_d) 00 01_h (1_d) register.

The data returned by the slave contains the length of the holding register in bytes (02_h) followed by the content of the register: 00 53_h → 83_d% of amplitude.

To tune it to 57% for example (39_h), the packet should be the following:

	Transaction ID	Protocole	Length	Slave ID	Function	Data
Master:	00 AC$_h$	00 00$_h$	00 06$_h$	05$_h$	06$_h$	0F A0 00 39$_h$
Slave:	00 AC$_h$	00 00$_h$	00 06$_h$	05$_h$	06$_h$	0F A0 00 39$_h$

The slave returns the same packet as it is a write command.

NB: The amplitude level can only be set between 50% and 100%.

3.4.3. Setting timers

The Hold and Afterburst timers can be adjusted via the registers 4024$_d$ and 4026$_d$.

Instead of setting them with two separate "Write Holding Register" commands, you might want to adjust both with a single command.

In that case you can use the "Write Multiple Registers" function (10$_h$) as follows:

	Trans. ID	Protocole	Length	Slave ID	Func.	Data
Master:	00 AD$_h$	00 00$_h$	00 0F$_h$	01$_h$	10$_h$	0F B7 00 03 06 00 00 03 E8 07 D0$_h$
Slave:	00 AD$_h$	00 00$_h$	00 06$_h$	01$_h$	10$_h$	0F B7 00 03$_h$

When writing multiple coils or registers, the length of the data to be written has to be specified. Here, the master asks slave 1 (01$_h$) to write to multiple holding registers (10$_h$), to the area starting at address 4023$_d$ (0F B7$_h$) and involving 3 registers (00 03$_h$), the 6 following bytes (06$_h$): 00 00 03 E8 07 D0$_h$.

As the Hold Timer includes registers 4024$_d$ and 4025$_d$, it will receive the first 4 bytes (each register is 2-byte wide). The Hold Timer is then set to 00 00 03 E8$_h$ → 1000$_d$ms. The last 2 bytes will go to register 4026$_d$, which means that the Afterburst time will be 07 D0$_h$ → 2000$_d$ms.

Note that this method is **only applicable to consecutive registers**.

The response from the device is the same frame without the written values.

4. Errors

In case an error occurs during the configuration (on startup), an error message will be displayed **in the Network Settings screen** and the server configuration will remain unchanged.

You may want to power-cycle your generator again. If the problem persists, please contact us.

5. Technical Support

Using the soniKKs generator with Modbus/TCP is normally easy. However, if a problem occurs, it is difficult to troubleshoot without an in-depth knowledge of Modbus and the system dynamics of polling.

❖ Some general guidelines for troubleshooting:

- Start polling slowly and increase speed gradually.
- Keep in mind that in many situations, the host application declares "No response" when in fact, the device did respond, and the application did not understand the response.

❖ Recommended poll rates

We recommend using the following values to configure your Modbus/TCP master, assuming that your network load and latency times are within the range of a few msec.

- response timeout: 275ms
- poll rate for fast-updating process values: 300ms
- poll rate for slow-updating process values (e.g. temperature, error code): 1000ms
- commands etc.: on demand

If you find stable results with these values when running the link over a longer period of time (2h+) you can try to lower the poll rate while keeping the response timeout untouched to allow for congestions to be gracefully resolved.

See below for a description of timeout factors to take into account.

❖ How fast can I poll?

It is important to understand that the link to the generator's processor is realized through a gateway from Modbus/TCP to a low-speed serial link. Therefore, you cannot expect to poll any faster than you could by a direct serial link. In fact, since you are adding a number of queuing systems between your application and device, you may even lose a bit of performance. For example, some download tests showed that remote download by Modbus/TCP bridged to Modbus/RTU ran about 20 percent slower than direct download by Modbus/RTU.

Above all, remember that the serial speed (or baud rate) consumes the largest amount of time. Suppose you issue a Modbus poll for 125 registers. This requires a 255-byte response, which at 115.2kbps (the speed of the serial link) requires over 22msec just to physically shift across the wire.

The overall time it takes to poll is the combined sum of these delays:

a. Delay for master/client to recognize need for poll.
b. Delay to issue and get the poll onto the Ethernet.
c. Delay for the poll to cross Ethernet and arrive error-free at the device (may include retries and contention).
d. Delay for Modbus/TCP gateway to process and queue Modbus/RTU poll.
e. Physical delay to shift poll bit-by-bit across the serial link.
f. Delay in the device to recognize, process, and start reply.
g. Physical delay to shift response out bit-by-bit across the serial link.
h. Delay for Modbus/TCP gateway to process and queue Modbus/TCP response.
i. Delay for the response to cross Ethernet and arrive error-free at the master/client (may include retries and contention).

Delay **a** is defined by your OPC or DDE driver. For example, a driver that runs only once each 55 msec (using the old DOS timer slice) can have a variable delay here of between 0 to 110 msec.

Delays **c** and **i** are defined by the complexity, load and link speed of your TCP/IP network. For example, if you are going through radio or satellite links, these delays routinely amount to 1000 msec (1 sec) or more per poll and another 1000 msec for a response.

Delays **e** and **g** are defined by the baud rate and the amount of data you want to transfer per request.

Delay **f** is defined by the device. The soniKKs implementation starts the reply within less than 5 msec.

Delays **d**, **e**, and **h** are defined by the load on the Modbus/TCP gateway.

❖ I cannot get a slave response

The soniKKs generator only expects and processes genuine Modbus/TCP from the network. Some applications just pack Modbus/RTU raw in TCP – this is not supported! Make sure that you choose "Modbus/TCP" as the protocol in your Modbus master application instead of "Modbus/RTU over TCP".

❖ What to do if polls fail

The soniKKs generator core probably cannot accept a new poll as fast as you are sending it over TCP.

TCP/IP is a full-duplex channel, and since you can have up to 8 active sockets, it is very easy to have a new request already waiting as your last poll's response is being returned. The only solution to this is to slow down your Modbus/TCP masters so that they never poll before the last poll's response has been seen. This manually creates the time delay between polls your device expects.

- My soniKKs generator runs fine for about 10 minutes and then my applications report it off-line.
- My soniKKs generator runs fine until it goes off-line, then it polls only intermittently.
- Sometimes my soniKKs generator returns the wrong data.
- After a while, the soniKKs generator seems to take longer and longer to answer. After a few hours, it takes 10 minutes or more for systems changes to propagate up to the master/client.

All these relate to the same issue: a mismatch in queuing behavior and expectation by the master/client to the new realities of Ethernet (it is not the generator behaving poorly). Resetting the generator fixes the problem (flushes the bloated TCP queues full of stale requests).

The core problem is that the master/client is using the old RS232/RS485 serial assumption that no answer means poll was lost. However, in the case of the Modbus/TCP gateway in between, it could also mean the gateway has not had time to answer because it is being overworked.

Also remember that TCP is reliable – the gateway receives all polls sent without error. The result is that the master/client retries, which makes it harder for the gateway to catch up.

Here is the scenario that is causing the problem:

1. Master sends out MB/TCP Poll #A with a timeout of 1000 msec.
2. Gateway receives the poll, but the serial link is busy so it waits - possibly another MB/TCP master is being serviced or timeouts waiting on off-line stations are creating a backlog of new requests.
3. After approximately 850 msec, the serial link is now free and the gateway forwards the MB/RTU request to the controller.
4. The gateway receives the response from the generator, and since the timeout on the gateway and master are not inherently synchronized, the gateway sends the MB/TCP response into the TCP socket.
5. In the best of times, it may take 5-10 msec for this response to actually go down the gateway's TCP stack, across the wire, and up the master's TCP stack. If a WAN or satellite is involved, it could take 750 msec or longer.
6. Meanwhile, before the master receives the Response #A, it gives up and makes the Modbus/RTU assumption that the request must have been lost. The master sends out a new MB/TCP Poll #B.
7. A few msec later, there is a response that looks like a good Response #B, but actually is Response #A. If the master does not use a sequence number (which many do not) and has forgotten about pending poll #A, it wrongly assumes this is response #B (possibly with catastrophic results if Poll #B was the same size but different register range). Here is the source of the problem "Generator returns the wrong data."
8. The master is idle and has no outstanding polls. Yet the gateway has received Poll #B by TCP/IP. It sends this out to Modbus/RTU slave and gets an answer, which means it's working normally and as expected.
9. The gateway then returns Response #B to the master (if the socket is still open) and there it sits in its TCP/IP buffer. The master is not expecting more responses, so it neither receives nor purges the "extra" response.
10. Master sends Poll #C and magically finds "a response" waiting as soon as it looks in the receive buffer - yet this is stale Response #B received before poll #C was even issued. If the master does not implement Modbus/TCP sequence numbers, then it accepts the response #B as satisfying poll #C.

Imagine if the master is putting out 300 polls per minute (5 polls per second), but the gateway can only process on average 290 of those per minute and some carry over. After 10 minutes, you may have up to 100 "stale" responses waiting in your master's TCP buffer. This makes it appear as though there is now a 20-second "lag" in data reaching the master. Here is the source of your "data taking longer and longer to propagate to Master/Client" problem.

However, if the master does implement Modbus/TCP sequence numbers, then the stale responses are rejected. If the master is smart enough to resynchronize itself (Response #B does not kill poll #C, but master waits more), then this resynchronization will manifest itself as the slave going off-line and back on-line intermittently. If the master is not smart enough to resynchronize, once this out-of-sync behavior occurs, your slave goes permanently off-line.

As you can see, this Modbus/TCP master is out of sync and the only cure may be to either restart the master or power cycle the soniKKs generator. Both actions close the socket and purge the backlogged messages.

The use of a gateway brings out this shortcoming in master/client Modbus/TCP designs, but even a pure MB/TCP-to-MB/TCP network would suffer from this problem if the poll cycle approached the average response time. Any Modbus/TCP network going through WAN will discover this.

Ideally the Modbus/TCP master application used should implement the sequence number and gracefully handle receipt of stale responses with unexpected sequence numbers. Unfortunately, the Modbus/TCP specification says that this sequence number is optional and can be used by a master to match responses to requests; however it can usually be just left as zero. The Modbus/TCP slave just echoes this back in the response. Anyway, most Modbus/TCP OPC servers today do not implement the sequence number.

So what is your solution if your Modbus/TCP master is first generation?

- Slow down your poll rate.
- You have to consider the worst-case response time – assume all polls timeout.
- If you are only polling a single slave (or poll one slave at a time), then you can try to disable the "MB Pipeline" option in the server configuration (see page 22). This will either help or make things hopelessly worse. If your OPC server or host application relies on pipelining to send more than one outstanding poll at once, then disabling the pipeline will essentially stop all data communication (in which case, you can just turn the pipeline back on !).

The ideal solution is for your Modbus/TCP master to not only support the Sequence Number, but also support the receipt of the 0x0A and 0x0B extended Modbus/TCP exception response. Then the master never needs to do retries – for each poll, it will receive either a value Modbus/TCP response or a Modbus/TCP exception that the slave is unreachable or timed out. This prevents the master from sending more polls than the gateway can process and building the TCP buffer queue up in the first place. You can enable the "use extended exception responses" in the server configuration as well (see page 22).

Troubleshooting

Error message	Possible reason	Repair
	➢ Transducer broken ➢ Short circuit at RF-cable ➢ Error on the generator ➢ Start frequency too close to resonance frequency	➢ Replace transducer ➢ Replace RF-cable ➢ Contact soniKKs ➢ Select higher value for start frequency
	➢ Transducer broken ➢ Error on the generator	➢ Replace transducer ➢ Contact soniKKs
	➢ Transducer not connected or broken ➢ Cable broken	➢ Connect or replace transducer ➢ Replace cable
	➢ Fan broken ➢ Error on the generator	➢ Check fan ➢ Check if air suctioning works ➢ Contact soniKKs
	➢ Generator overloaded	➢ Reduce compacting pressure ➢ Use generator with more power

Maintenance and care

There is no need for special maintenance! Please remove any dust and dirt with a damp woven fabric. Do not use any chemicals to clean the device. Keep the cooling slots clear all time.

Warranty

The period and extent of the warranty is part of the commercial terms and conditions. Special agreements are part of the confirmation of the order.

The warranty does not cover any malfunctions, injuries and damages that result from such use or improper operation in use.

Warranty exclusion applies in the following cases:

- Damage due to wrong handling or tampering
- Damage due to wrong application
- Damage due to shock, dirt or moisture
- Damage due to operation by non-qualified staff
- Damage due to nonobservance of safety regulations or accident prevention regulations
- Damage due to modifications to the operating manual

Imprint

Purpose and use

The operating manual explains the handling and operation of the display and the firmware in connection with standard accessories for use in laboratories and the industry.

Please read especially the safety instructions carefully and observe them all.

The operating manual should always be at hand, to help you to solve any questions and problems that may arise.

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This manual has been prepared with all due care, nevertheless faults and omissions cannot be fully precluded.

soniKKs GmbH reserves the right to make changes to the technical data and specifications during the curse of further development of the product. Without given prior notice.

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